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STRUCTURE OF FAMILY GROUPS AND SPACE USE BY STEPPE MARMOTS (*MARMOTA BOBAC*): PRELIMINARY RESULTS

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Structure of Family Groups and Space Use by Steppe Marmots (*Marmota bobac*): Preliminary Results. Nikol'skii A. A., Savchenko G. A. — The structure of family groups on the basis of observation on individually tagged marmots (*Marmota bobac* Müller) is described. In all 48 captured animals from 11 permanent burrows (including 17 adult females and 26 adult males) were tagged during 1994-1997. Density of families in the biotopes of intensive grazing is 1.9 family/ha. In late summer the home range area of one of the groups under observation was 0.36 ha. In the biotopes of moderate grazing the density is 0.8 family/ha. The home range area of one of the groups during the same observation period was 0.53 ha. In the biotopes of low anthropic influence the population density is less than 0.3 family/ha. The home range area of one of the groups is 0.83 ha. Observations show that in most cases a family group consisted of an adult female with offspring or without it and 2 to 3 adult males. Groups are relatively unstable: during one month observation period there were registered a number of animals' passages from one group to another separated by a rather great distance (more than 300 m). Marmots visit neighbouring home ranges and in some cases move to those become free for some reasons.

Key words: steppe marmot, *Marmota bobac*, behaviour, family group, space use, home range, activity centres.

Структура семейных групп и использование территории степными сурками (*Marmota bobac*): предварительные результаты. Никольский А. А., Савченко Г. А. — На основании наблюдения за индивидуально мечеными степными сурками (*Marmota bobac* Müller) описывается структура семейных групп и использование животными территории. В 1994—1997 гг. было помечено 48 животных, отловленных из 11 постоянных нор, из них 17 взрослых самок и 26 взрослых самцов. Плотность семей в биотопах с интенсивным выпасом составляет 1,9 семьи/га. Площадь участка одной из наблюдаемых здесь групп составляла в конце лета 0,36 га. В биотопах с умеренным выпасом плотность — 0,8 семьи/га. Площадь участка группы в тот же период наблюдений — 0,53 га. В биотопах с низким уровнем антропогенной нагрузки плотность населения сурков — менее 0,3 семьи/га. Площадь семейного участка — 0,83 га. Наблюдения показали, что в большинстве случаев семейная группа состоит из взрослой самки с потомством или без него и 2—3 взрослых самцов. Группы относительно нестабильны: в течение периода наблюдений, равного примерно одному месяцу, регистрировались переходы животных из одной группы в другую на значительные расстояния (более чем 300 м). Сурки посещают соседние семейные участки, а также переселяются на участки, освобождающиеся по той или иной причине.

Ключевые слова: степной сурок, *Marmota bobac*, поведение, семейная группа, использование территории, семейный участок, центры активности.

According to the existing notion, marmots settlements consist of families. Each family implies a group of jointly hibernating animals which for a number of years use a definite territory including a foraging area and a refuge (Bibikov, 1989; Kolesnikov, 1997; Mashkin, 1997). However, detailed observations on individually tagged animals are practically unavailable that makes the interpretation of the earlier published data rather difficult. This work is aimed at the description of the structure of family groups on the basis of observation on individually tagged marmots and some peculiarities using by animals of space.

Material and methods

In 1994–1997 observations were carried out in the following periods: from May to mid-June and from mid-July to mid-September. For stationary observations a typical steppe marmot settlement was chosen in north-eastern Ukraine, Kharkov region, Velikoburluk district in the vicinity of Nesterivka village (about 90 km to the north-east of Kharkov). The steppe marmot is common in that region.

Three types of steppe marmot biotopes may be identified depending on the degree of anthropogenic influence on the tagging site: 1) a territory practically unused (low level anthropogenic influence). The first degree of the pasture degeneration of the vegetative cover according to the gradation of L. G. Ramensky (1971); 2) a territory with a moderate grazing or regular hay-making (middle level anthropogenic influence). The third and the fourth gradations of the pastoral degeneration; 3) plots with permanent overgrazing (high level anthropogenic influence). The fourth and the fifth gradations of the pastoral degeneration. The phytocenological analysis (0.25 square-meter method) showed that the total terraneous phytomass (together the died-off plant mass) is at the average 322.5 g/m^2 (dry mass) in the biotopes of the first type; 173.7 g/m^2 in those of the second type and 103.3 g/m^2 in the biotopes of the third type (see also Ronkin, Savchenko, 1996).

Animals jointly living in the same permanent burrow or in a system of burrows within a given period of time were considered as members of one family group. They were tagged with colour plastic ear tags of Hauptner Ltd. (Germany) using the Dalton Ltd. marker (Germany). Females were tagged on their left ear and males on the right one. Additionally, black-coloured numbers were painted and fur was sheared off with scissors on the sides of animals. The number were distinctly visible at a distance up to 300 m.

The total area of the stationary site is about 25 ha. To determine space use of marmots an area of 5 ha was subdivided into a grid of squares of 20 m×20 m. Observations were carried out with binoculars and a field glass. The observer remained in the same place at a distance of 200–300 m from the object in a natural shelter on the hill top. The location of tagged animals in the squares of the reference grid was registered. At the same time animals' activity patterns were fixed. The results were entered into the computer data base and processed using the ELLIPS program, developed by A. T. Terekhin, A. A. Nikol'skii and V. Yu. Rumiantsev. The program shows the individual home ranges of animals as an ellipse, approximating the two-dimensional distribution of the territory used with any given probability. We assumed a 95% probability. It means that within the territory limited by the ellipse the occurrence of a given individual may take place with the mentioned probability. The activity centre is calculated by the program as a coordinate of the mean on both axes X, Y. The centres of activity were computed as the weighted average of the quadrate centre coordinates (Hayne, 1949). The ellipse area corresponds to that of an individual range with the given probability (Nikol'skii, Mukhamediev, 1996, 1997). To calculate a home range a sampling integrated over all the members of the group was entered into the database. A plot of 6 ha area was separated within each biotope type where all the families available were counted.

In all, there were tagged 48 animals captured from 11 permanent burrows involving 17 adult females, 26 adult males, 4 young (i. e., the animals of the first summer), 1 subadult male (i. e., a young that survived after the first hibernation. In April-July the subadults substantially differ from the adults in their dimensions and weight).

Results

The study carried out in 1992–1997 showed that, as a rule, two family groups lived within the 6 ha plot in the biotopes of low level anthropogenic influence. However, in July–August 1993 and in July-August 1995 only one group of marmots lived on this territory. Thus, the population density within the count plot was less than 0.3 family/ha. Late in summer the range area of one of the groups under observation was 0.83 ha. As to the biotopes with moderate grazing usually five family groups were met within the 6 ha plot in 1994–1997, the density constituted 0.8 family/ha. The home range area of one of the groups in the same observation period was 0.53 ha. At the same time in the biotopes of intensive grazing 11–12 groups were observed within the 6 ha plot, density of families was 1.9 family/ha. The home range area of one of the groups was 0.36 ha.

Observations showed that in most cases a family group consisted of an adult female with offspring or without it and 2 to 3 adult males. Groups are relatively unstable: within an observation period of about one month there were registered a number of animals' passages from one group to another separated by a rather great distance (more then 300 m). Marmots visit neighbouring home ranges and in some cases move to those become free for some reasons.

In 1995 home range observations were carried out on the territory of intensive grazing. Within the borders of the tagging site (coordinate grid) there was located the

family group № 1 consisting of an adult female, two adult males and two young of different sexes. The composition of the group remained unchanged not only during the whole field observation period 1995 but also in early spring 1996. The borders of the individual home ranges of all group members are presented in fig. 1. The activity centres are concentrated in a square with 70×70 m centre coordinates where the only permanent burrow of this group was located. The activity centres of the adult male (m13) and the she-young (f4) are displaced to the left. The big halfaxes of individual home ranges belonging to adult males m12 and m13 are almost perpendicular to each other.

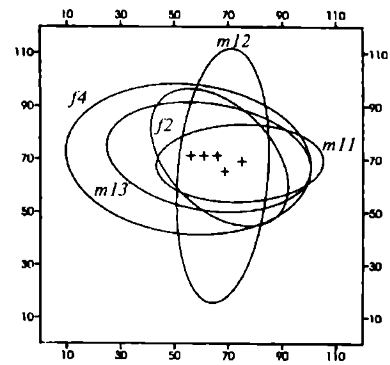


Fig. 1. The boundaries of individual home ranges (the ellipses) and the activity centres (the crosses) of the family group № 1. August, 1995. m — males; f — females. The figures by *m13* and *f4* are the individual number of each animals.

Рис. 1. Границы индивидуальных участков (эллипсы) и центры активности (крестики) семейной группы № 1. Август 1995 г. m — самцы; f — самки. Сокращения *m13* и *f4* соотвествуют индивидуальным номерам животных.

The permanent burrow of the neighbouring group № 1, *A* is located at a distance of 60 m. Its inhabitants — 4 adult males, 1 adult female and a male young after their capture were under a permanent observations. Subsequently observations they were noticed among the members of different groups, one of the adult males (m15) being seen in August at a distance more that 300 m from the place of his capture whereas in September he was fixed in the group inhabiting burrow № 1, *A* again. Once (on the 4th of September) the same male was observed visiting permanent burrow № 1 at the moment when all of its inhabitants were present. The visit to the burrow was a very short one (less than 1 minute) after which the visitor appeared above ground in the company of an adult male and returned peacefully to his home burrow. During another observation there was noticed agonistic behaviour between two neighbouring young: an untagged young of group № 1, *A* chased off a male young of 1 group who neared very closely to the borders of the square with the permanent burrow.

In 1996 observations were performed in biotopes of moderate grazing (middle level anthropogenic influence). 8 animals belonging to 4 family groups were under observation. The composition of only one of the groups was determined in full. This group was conventionally designated as № 2 and consisted of an adult female f2 and two adult males m11 and m14, respectively. The individual home range of male m14 is displaced in the direction of the neighbouring home range i. e. to the place of his capture. The activity centres of the males are at a maximum distance from one another (fig. 2, *A*). This group has regularly used 3 permanent burrows in the squares with 150×70 m, 150×90 m and 170×130 m centres. The composition of the group № 2 (inhabiting this burrow system) changed several times during the investigation period. In May 1997 it was the following one: a female f2, a male m11 and two subadult animals. The individual home range borders of the adult marmots are presented in fig. 2, *B*. The home range of the female exceeds that of the previous August.

In August 1997 the composition of group № 2 changed again and was as follows: an adult female f201, an adult male m205 and subadult male m202. (All the animals were captured within the given home range and tagged on July 30, 1997). Their individual home range borders lie within those of former residents, and the activity centres of the newcomers are displaced to the centre of the home range from its periphery deeply into the family territory (fig. 2, *C*).

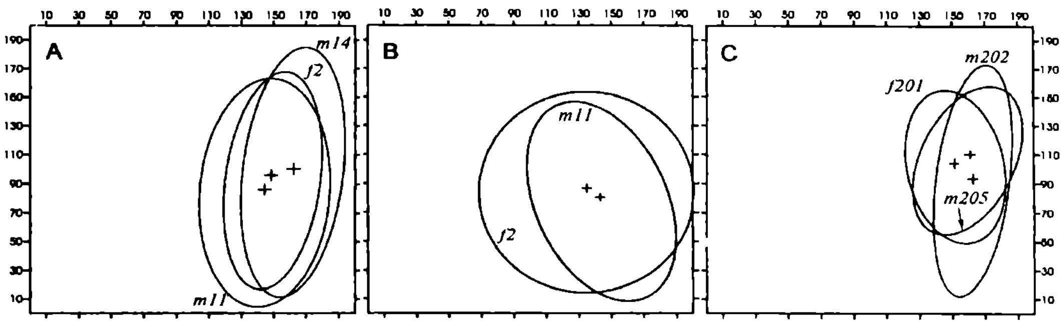


Fig. 2. The boundaries of individual home ranges and the activity centres of the family group N 2 (look the legends in fig. 1): A — August, 1996. The composition of the group: adult female N 2, adult males N 11, 14; B — May, 1997. The change in the group composition: adult female N 2, adult male N 11; C — August, 1997. The change in the group composition: adult female N 201, adult male N 205, subadult male N 202.

Рис. 2. Границы индивидуальных участков и центры активности семейной группы № 2 (см. подписи к рис. 1): A — август 1996 г. Состав группы: взрослая самка № 2, взрослые самцы № 11, 14; B — май 1997 г. Изменения в составе группы: взрослая самка № 2, взрослый самец № 11; C — август 1997. Изменения в составе группы: взрослая самка № 201, взрослый самец № 205, полувзрослый самец № 202.

Discussion

Observations on the tagged animals showed that it is males that are prevailing among adult animals. As a rule, a family group consists of 2 to 3 males and one female. In one case there were two females in a group but one of them left in a short time.

The possibility of polyandry in steppe marmots was discussed in literature (Rymalow, 1997). However, the histological analysis of the *M. bobac schaganensis* Bashanov, 1930 testicles showed that in spring only 58.3±4.9% individuals take part in reproduction (Shevlyuk, 1997). According to Kolesnikov (1997) only one pair of adult marmots in family reproduces.

A family group of the European marmot (*M. marmota* Linnaeus, 1758) also often consists of several adult males but only one of them exhibits territorial domination (Arnold, Dittami, 1997). An exactly opposite tendency in family group organisation is observed in the yellow-bellied marmot (*M. flaviventris* Audubon et Bachman, 1841). Each family group of this species involves one adult male and one (or several) adult females (Armitage, 1962).

A wide spectrum of interspecific differences and, in some cases, the geographical change ability in social organisation of the New World marmot allowed D. P. Barash (1979, 1989) to suggest that the family group number is influenced by the length of the vegetation period. He advanced the hypothesis concerning the tendency to a solitary mode of life in species (or populations) living in favourable environment. May serve as an extreme example the woodchuck (*M. monax* Linnaeus, 1758) the males and females of which come together only during the mating period (Swihart, 1992) suggests that a limited amount of social cohesion or tolerance may extend beyond the periods of breeding and weaning). The other extreme is the Olympic marmot (*M. olympus* Merriam, 1898). Its numerous family groups include a great number of adult individuals.

The conception of D. P. Barash is interesting but needs a further verification because the vegetation duration may be neither the single nor even the main limiting factor as was mentioned, for example, by Arnold (1990) and Blumstein (1996). In their work they discuss the influence of the necessity in "social thermoregulation" (Arnold, 1990) and heightened group vigilance (Blumstein, 1996) on the marmot group number.

In the European marmot the inclusion of any "additional" males may even lead to the mother-son coupling (Arnold, Dittami, 1997).

In the opinion of some authors, the availability of clearly defined family range borders in marmots is explained by their attachment to burrows of different biological destination, and to a foraging area satisfying demands of the animals in nourishment during the whole active period (Bibikov, 1989; Mashkin, 1997). The linear borders of a family on a territory are precisely defined by visual observations on vital activity of animals or by the traces of the latter (Mashkin, 1997). According to our observations the mentioned above borders may be precisely defined only for the main territory of the home range and only for a group as a whole, i. e. integrated on all its members.

An adult female seem to be a kernel of a group of marmots with a territory in common use. Her individual home range borders surround the main burrow rather uniformly (the ellipses' axes are nearly equal). The activity centre lay in the nearest vicinity of the burrow during the whole period of observations.

Individual home ranges of males are usually stretched out and their activity centres are displaced relative to the main burrow. Generally males travel at longer distances than females do. A case was registered when male m15 travelled a distance of 300 m off the burrow usually used by him. Not seldom are cases when a male caught from a permanent burrow appears in some neighbouring group (e. g. this was the case with an adult female). Individual home ranges of adult males overlap only in the nearest vicinity of the main burrow (group № 1). Or, they are, as well as, activity centres, separated from one another at a maximum distance (group № 2). The individual home range of a male remains relatively stretched out during the whole period of activity.

The borders of the individual home ranges of new residents lie within those of old ones and their activity centres are displaced from the periphery to the centre. Probably the territory close to the main burrow is used by new residents first, whereas the periphery much later (see also Lenti Boero (1995) in relation to the Alpine marmot).

Generally, space use by new residents probably is connected with the gradients of the biologic signal field generated by vital activity traces of preceding generations (Nikol'skii, Mukhamediev, 1995).

The result of comparing the home range areas of the family groups is as follows: group № 1 (the biotope of intensive grazing, high level anthropogenic influence) possesses an area of the territory in common use by 1.6 less than group № 2 (the biotope of moderate grazing, middle level anthropogenic influence) i. e. 0.36 and 0.53 ha respectively. Our data received for the area of common use in group № 1 coincide with the observations of Tokarsky (1997) but our attempts to determine seasonal changes in individual home range areas were unsuccessful. So far we can state the following: 1) in late summer the individual home range areas of adult females are less than those of adult males; 2) in May the individual home range area of one of the adult females was 2 times greater than those in late summer (1.46 and 0.70 ha, respectively).

The steppe marmot groups under observation collectively using a territory are not stable which is especially characteristic in biotopes of intensive grazing (high level anthropogenic influence) preferred by marmots. In biotopes less suitable for steppe marmot habitation (without any practical utilisation), the groups probably are more stable.

Analysis of the data on spatial use by steppe marmots shows the fact that the changes in population density of animals connected with the practical utilisation of territory are caused by corresponding changes in distribution density of separate families (Seredneva, 1978). This is due to the diminishing in regular resources of home ranges, i. e. in permanent burrow number and the area of territory in common use.

The size of the home-ranges used by different marmot species varies within very wide limits. Mann and Janeau (1988), for example, noticed that a family group of the European marmot may use a territory from 0.8 ha to 5.75 ha depending on their habitat. Barash (1989) in his summarizing monograph pays attention to the fact that the

individual home-range of even one species may vary within extremely wide limits: from less than 1 ha to more than 10 ha.

Probably, the composition and the number of family groups, as well as their home-range size, depend on the influence of a number of factors. In this context of considerable interest is the observation of Blumstein and Foggin (1997) concerning the fact that in the long-tailed marmot (*M. caudata aurea* Blanford, 1879) the group home-range size does not depend on the availability of food resources.

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